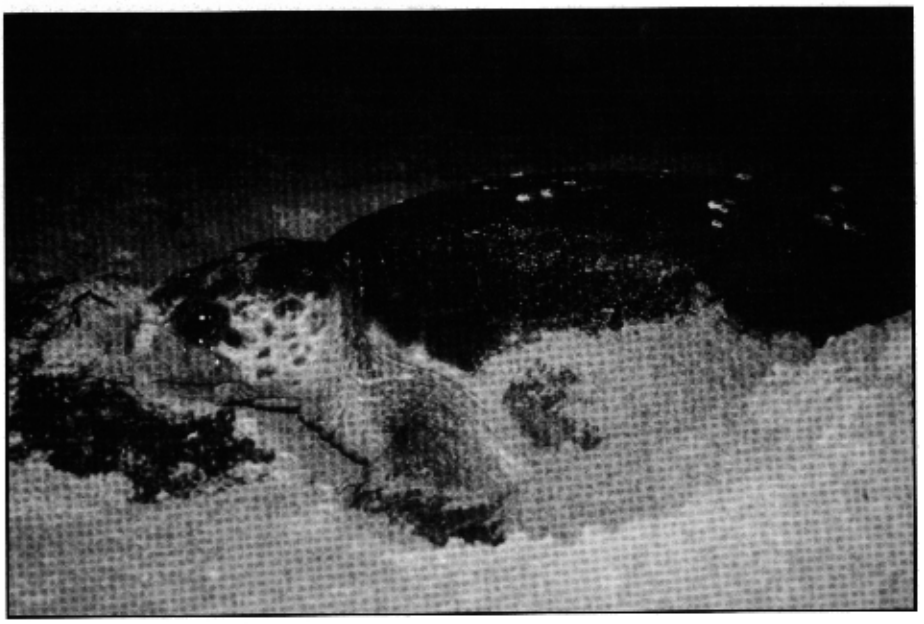
Title: Improved Assessment, Sampling, and Economic Methods for Wildlife Damage Management

Goal: Develop and validate new techniques to assess, sample, and quanitify wildlife damage management, plus determine related benefits and costs.

Optimizing Control of Predators To Prevent Depredations on Sea Turtle Nests—Unchecked, raccoons and armadillos prey on a high percentage of sea turtle nests on many Florida beaches. Hobe Sound National Wildlife Refuge on Florida's east coast was established to provide and protect nesting habitat for three species of threatened or endangered sea turtles. All three species build nests and hatch their young from spring to fall. This pattern results in at least 6 months where nests are vulnerable to predation, but funds are only available to hire a WS employee for 1 month to control predators.

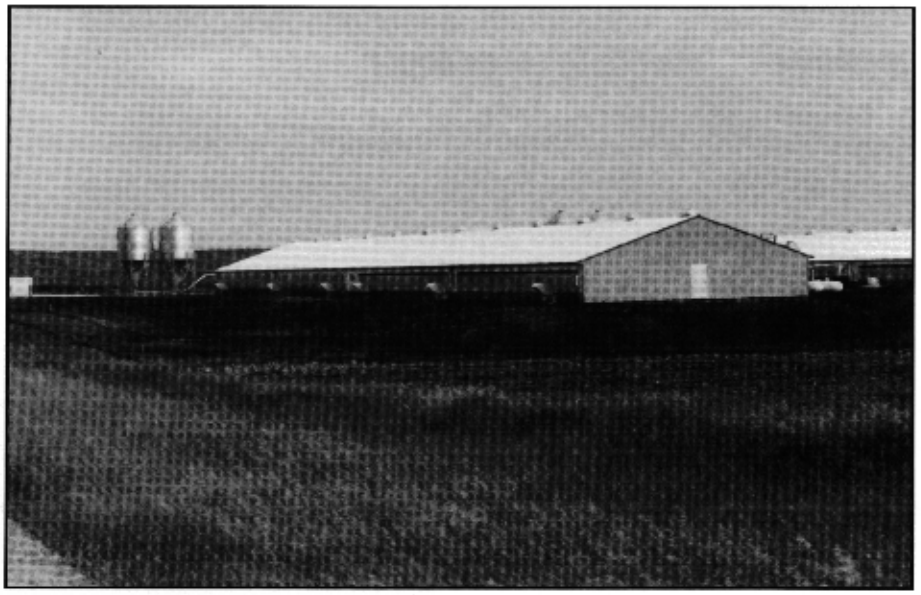
An NWRC Fort Collins biologist worked with Florida WS personnel to develop and test a passive tracking method for indexing predator populations along beach areas of the refuge. The indexing data were used to help increase the efficacy and efficiency of these control efforts by (1) optimizing the timing for conducting control, (2) minimizing labor by targeting specific areas for control, (3) assessing control efficacy, (4) identifying raccoon reinvasion patterns, and (5) providing predictive data regarding the next year's turtle nesting season.



The proportion of nests predated when using the tracking index to monitor numbers and location of predations in conjunction with control was 28 percent, the lowest rate in years. In 1999, with the same level of control but without the benefit of predator monitoring, the predation rate was 42 percent. Without control, nest predation has been as high as 95 percent. Research is continuing to improve the monitoring method, especially by refining the method for more sensitivity to armadillos.

Benefit:Cost Projections for Golf Course Use of a Turf Repellant—Canada goose feces on fairways and greens could cause reduced purchase of golf course fees. In 2000, NWRC scientists estimated the economic variables related to using wildlife damage repellants on golf courses. Direct benefit:cost ratios were computed for a commercial repellant (ReJex-It®) registered for use to prevent loafing and grazing of waterfowl on turf. Estimates assumed (1) local summer greens fees ($46/18 holes and $25/9 holes), (2) busy "starting times" of foursomes (i.e., 7.5, 18-hole rounds/h between 5:30 a.m. and 5:30 p.m. and 7.5, 9-hole rounds/h between 5:30 p.m. and 7:00 p.m.), and (3) commercial pricing of ReJex-It at $69.95/gal at a recommended application rate of 2.5 gal/ac. Iterative calculations were derived based upon potentially reduced sales of greens fees (i.e., 2, 4, 6, ... 30 percent) due to golfer dissatisfaction over goose feces and varied applicator costs (i.e., $2, $4, $6, $8, and $10/ac) for areas of 8 and 25 ac.

Under the hypothesized scenario, spraying of only limited acreage is profitable even if complete repellancy of geese, as measured by no droppings, is assumed. The break-even point (benefit:cost = 1.0) for use of the repellant occurs when a 12-percent and 24-percent loss of greens fees is expected for 8 and 25 ac, respectively. Application costs seemed to have minor effects on the ratios, at least for the range of $2.00 to $10.00/ac.



An Economic Analysis of Integrated Rodent Control in Swine Production Facilities—A comprehensive economic analysis of rodent control at swine production facilities was conducted using funds provided by the pork industry. An interdisciplinary working group of scientists from NWRC, academia, industry, and other government agencies was assembled to identify key input variables and cost values associated with rodent damage and control at swine production facilities. Data from production models, scientific literature, product literature, and personal experience were incorporated into an interactive STELLA Systems Model. Use of this model allowed predictions of benefits and costs for varied inputs of house mouse damage and control; outputs were site specific. A Web site on rodent control [http://itg3.unl.edu/rodent —username "rodent" and password "tnedor"] was established to promote use of the model, increase producer awareness of the costs associated with rodent damage, and provide information on integrated strategies for managing rodents at swine-rearing facilities. While the model is relatively robust and complete, it still has certain gaps in research-based information, particularly in the areas of economic impacts of rodents on swine disease, food safety, quality assurance, and farming.

Title: Development of an Avian Infertility Tool for Application in Goose Management

Goal: Test the effectiveness and develop for use the contraceptive nicarbazin for reproductive control of geese.

Field Efficacy Study With Nicarbazin in Fort Collins—Canada geese damage crops and deface property with their feces. In addition, they can pose health risks when feces contaminate potable water supplies. In recent years, resident goose populations have been growing. In such situations, it may be neither practical nor desirable to control resident populations through the use of hunting. Contraception provides a potential nonlethal alternative to manage resident geese populations.

Nicarbazin is a promising oral contraceptive that traditionally has been used to treat coccidiosis in chickens. In the spring of 2001, nicarbazin was coated onto cracked corn and fed to two Fort Collins goose populations. Baiting occurred daily at loafing sites and within some nesting territories. Nest boxes were checked periodically for eggs and hatching. Any eggs that did not hatch were collected for analysis.

Nicarbazin reduced hatchability at one site by 70 percent. In addition to monitoring nesting success, geese were fitted with neck collars to allow for the monitoring of movements outside of the nesting season.

Nicarbazin Dose Study in Penned Geese—During spring 2000, a study was conducted in Wisconsin testing the potential of nicarbazin as a contraceptive on Canada geese. The study objectives were to evaluate the ability of wildlife managers to hand-feed adequate daily doses of nicarbazin to individually marked resident Canada geese and to evaluate the efficacy of nicarbazin for reducing the reproductive success of the

geese. The study was conducted prior to and during the egg-laying period at a wildlife sanctuary that has a large population of free-ranging resident geese that were accustomed to being fed by people.

Twenty-five adult females were marked with individually identifiable neck collars, 16 of which had radio transmitters affixed to them. Nicarbazin slow-release grit pellets and capsules containing nicarbazin were fed during March and April 2001. To increase acceptance by geese, grit pellets and capsules were concealed in breadballs or kernels of corn. Each day, marked geese were offered three grit pellets containing 125 mg nicarbazin per pellet and one capsule containing 125 mg nicarbazin, but daily doses received by individual geese varied throughout the study because geese did not always come to the feeding site.

Due to the rapid clearing of nicarbazin from a goose's system (3 or fewer days), none of the geese ingested adequate daily doses before and during the nesting period, so the nicarbazin treatments were less successful than expected. Of the marked geese, only six established nests within 60 miles of the study site and received continued doses of nicarbazin. Of the 35 eggs laid by these geese, 83 percent hatched. The data collected on "resident" geese movement patterns and nesting locations showed that a large proportion of the resident geese nested in remote, inaccessible areas, away from the sanctuary. Traditional management techniques such as nest destruction would not be applicable with these geese.

The results strongly support the need for an orally fed reproductive inhibitor that is administered prior to and during nesting. The biggest challenge to developing an orally fed reproductive inhibitor will be to produce a bait that is palatable relative to other food sources at the time of breeding, when geese typically switch to a green grass diet, and to develop methods to entice birds to bait sites at a time when they are pairing up, becoming territorial, and moving to nesting sites.

Title: Field Evaluation of Chemical Methods for Brown Tree Snake Management

Goal: Develop techniques to help control brown tree snakes on Guam and prevent their dispersal from that island.

The brown tree snake (BTS), an accidentally introduced species to the island of Guam, has decimated that island's native fauna and poses a similar threat to other Pacific island ecosystems. NWRC scientists are field-testing chemical methods for controlling the BTS. NWRC is evaluating toxicants, attractants, repellants, and fumigants that could be used in an integrated program to control the BTS on and prevent its dispersal from Guam and reduce or help control snake populations in other island situations. The Center's goals are to field-test these methods for efficacy and make them available for use by a variety of individuals and organizations, including WS, Federal and State agencies, natural resource managers, military personnel, and others to use in controlling the BTS.

Dermal Toxicant Delivery to the BTS by an Automatic Aerosol Device—Previous investigations have shown that commercial insecticide aerosol formulations registered by EPA are dermally toxic when sprayed on physically restrained BTSs. In an effort to use insecticide aerosols for practical snake control applications, a passive aerosol dispenser was evaluated under laboratory conditions for delivering pyrethrins containing the synergists piperonyl butoxide and N–octyl bicycloheptene. NWRC scientists developed an infrared (IR) electromechanical aerosol dispenser that directs a spray for 3 seconds to the body of a snake when the IR beam is tripped by the snake as it crawls into a pipe to investigate a dead mouse lure. Operational use of passive aerosol dispensers could be in warehouses and cargo staging areas, where there is potential for snakes to enter into sea and air transportation systems.

Snake mortality with pyrethrins in concentrations of 0.25, 0.5, 1, and 2 percent was 17, 43, 60, and 88 percent, respectively. These results are encouraging. However, this was the initial evaluation of the passive aerosol dispenser, and refinements such as optimal spray particle size, carrier for the active ingredients, and convenient electrical power supply need to be made to increase its efficacy and practicality. Also, the dead mouse is not a practical lure for this device because it decomposes in 2 to 4 days. An artificial lure with a longevity of at least 7 days would make this device more effective.

Postmortem Residues of Acetaminophen in the BTS—Dead neonatal mice (DNM) baits containing 80 mg acetaminophen are effective toxicants for the BTS under field conditions, but the environmental fate of acetaminophen residues in dead snakes is not

known. To address this issue, residues of acetaminophen in BTSs killed by consuming a dead mouse bait treated with 80 mg acetaminophen under laboratory conditions were determined by NWRC chemists. Five test groups, each containing three control and six treated snakes, were evaluated. Control snakes, fed an untreated bait, were euthanized. Postmortem Day 0 snakes were immediately frozen and the other groups were exposed in an environmental chamber to field ambient temperature and humidity conditions for 1, 2, 3, and 4 days. Of the 30 treated snakes, 28 consumed the bait and all died, including 7 snakes that regurgitated the bait.

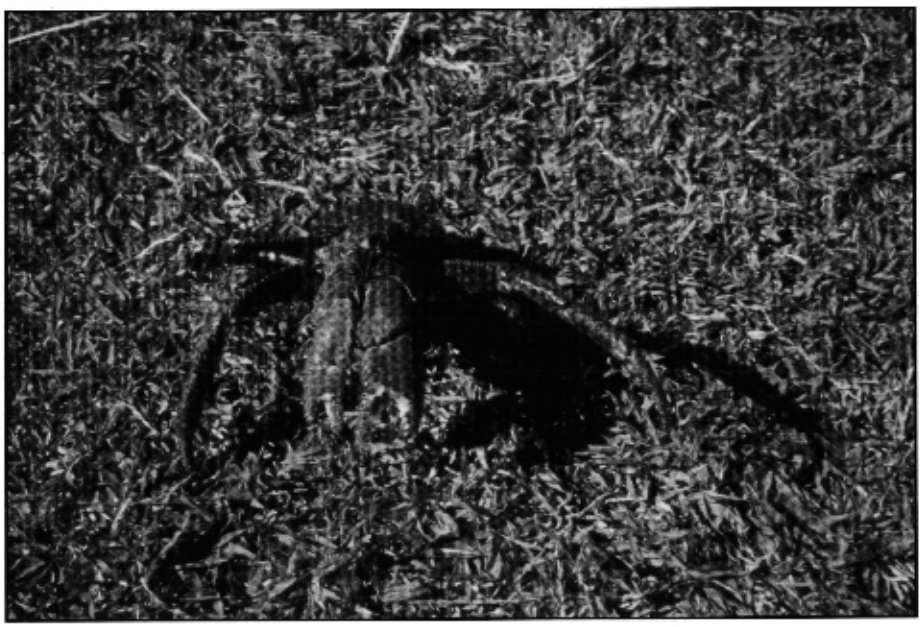
Total acetaminophen residues in snakes that regurgitated the bait ranged from 0.3 to 1.2 mg during the postmortem period. For the snakes that did not regurgitate, the average acetaminophen residues were 38, 24, 30, 5.1, and 4.7 mg at postmortem days 0, 1, 2, 3, and 4, respectively. The percentage of acetaminophen recovered from the initial dose of 80 mg ranged from 48 percent at postmortem Day 0, to 6 percent at postmortem Day 4. Residue data will be used for making potential secondary hazard assessments for the endangered Marianas crow and other potential scavengers and will be submitted to EPA to support registration of acetaminophen as an oral toxicant for the BTS.

Toxicity of Acetaminophen and Caffeine 40 mg Tablets in "Heavy" BTSs—There is a wide range in the size of the BTS on Guam, and an oral dose of toxicant must be sufficiently potent to be effective for large snakes. The majority of NWRC's toxicity studies have been conducted with snakes weighing between 40 and 100 g, but larger snakes are frequently encountered in the field. Previous studies with 80 mg acetaminophen and caffeine tablets in DNM baits resulted in 100-percent mortality in large snakes weighing about 140 to 300 g.

This study was conducted to determine the toxicity profile of 40 mg acetaminophen and caffeine baits on large snakes. Mortality was 90 percent for caffeine and 100 percent for acetaminophen in snakes with mean body weights of almost 200 g. None of the snakes regurgitated the caffeine baits and only 1 of the 10 snakes regurgitated the acetaminophen bait, but it died. Although the 40-mg caffeine dose did not kill all the heavier snakes, the 80-mg dose did. Caffeine would be an acceptable substitute for acetaminophen should major obstacles develop in its use for operational control.

Acetaminophen Toxicity in Crabs—Crabs also are nontarget animals that could be exposed to acetaminophen by feeding on treated baits (primary toxicity) or by feeding on snakes killed by acetaminophen (secondary toxicity). In tests conducted on Guam under laboratory conditions with individually caged coconut and hermit crabs, no mortality or sign of toxicosis were observed in any of the trials with either species. In all the primary toxicity test trials, crabs ate the bait matrix, but the majority of them avoided eating the acetaminophen tablets. In the coconut crab secondary toxicity test, no mortality or signs of toxicosis were observed from eating snakes that died after consuming 160 mg acetaminophen, which is twice the dose used in field trials. These test results indicate that primary and secondary hazards of acetaminophen to crabs are negligible. These data are also being used in support of an EPA registration for acetaminophen as an oral toxicant for BTS.

Comparison of Trapping and Baiting—During 2001, NWRC researchers and Guam-based WS operations staff collaborated on a demonstration project to test and develop an operationally practical and cost-effective integrated pest management strategy to reduce BTS populations. This demonstration project, which consisted of trapping and toxicant baiting techniques, was conducted with the military in 20 rectangular forested plots totaling 150 ha. Snakes had been previously trapped on some plots by Guam WS opera-



tions staff 12 months prior to the initiation of this study. Two replicates, each consisting of five previously trapped and five untrapped plots, received acetaminophen toxicant treatments.

In the first replicate, the mean toxicant bait take on the five previously untrapped forest plots was initially 80 percent and declined to 21 percent after 4 weeks of baiting. In the second replicate, mean toxicant bait take on five other previously untrapped forest plots was initially 62 percent and declined to 25 percent after 4 weeks of toxicant use. The mean toxicant bait take in the first replicate on five previously trapped forest plots was initially 56 percent and declined to 14 percent after 4 weeks of toxicant use. In the second replicate, mean toxicant bait take on five other previously trapped forest plots was initially 44 percent and declined to 24 percent after 4 weeks of toxicant use.

These results indicate that toxicant baiting is an effective control technique but also that, even with 12 months of continuous trapping effort, many snakes remain uncaught. A cost:benefit analysis of this integrated operation effort is underway.

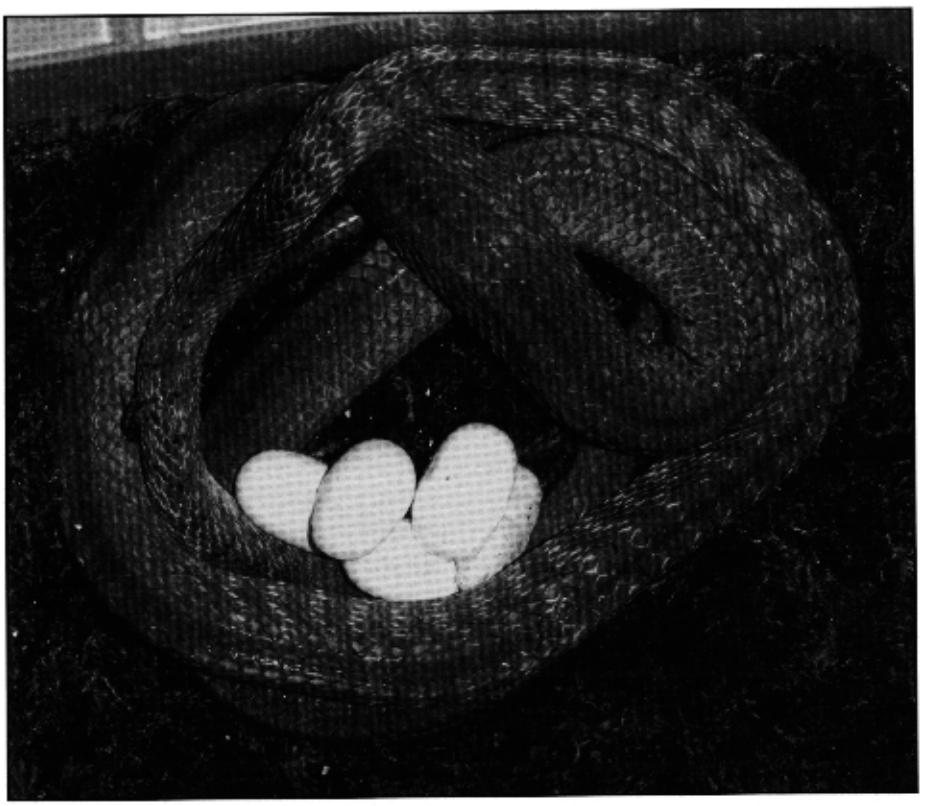
Guam Rail Restoration and BTS Baiting—A study was initiated to collect data to assess the potential risk to Guam rail restoration in sites on Guam where acetaminophen is placed in DNM for BTS control. The study was conducted in two parts over a 12-day period. The first study assessed if 20 Guam rails hatched and raised on Guam that have never encountered DNM as a food item would feed on DNM placed on the ground of the holding pen or placed in a food bowl in the holding pen. The second study assessed if four Guam rails hatched and raised in zoos in the United States that encountered DNM in the past as a food item would feed on DNM placed on the ground of the holding pen or in a food bowl.

To briefly summarize the results, no Guam rails that were hatched and captive-reared on Guam ate DNM. However, all rails that were captive-reared in zoos and sent to Guam as part of the breeding program ate DNM. Six rails were observed eating DNM. In five cases, DNM were eaten whole. In the sixth, the mouse was torn apart before being eaten.

These results suggest that captive-reared rails that may have previously been fed DNM are likely at some risk in sites where toxicants placed in DNM lures are used. However, the assessment of risk needs to be placed in the context of the baiting strategy, delivery mechanisms, and behavior of the rails.

Successful Reproduction of the BTS in Captivity—As part of a multiagency effort to develop methods for controlling this species, NWRC research also focuses on developing methods for inhibiting reproduction. As a prerequisite step to this effort, wild-caught adult BTSs were brought into captivity at the NWRC in May 2000 to form the nucleus of a potential breeding colony. The objective was to develop a method for inducing reproduction in the laboratory so potential reproductive inhibitors could be evaluated in a controlled laboratory setting. After a 250-day acclimation period followed by a 78-day simulated wet season (i.e., cool temperatures and high humidity), pairs of snakes were set up and observed for mating activity.

Of 52 pairings involving 10 males and 23 females, 10 pairing attempts culminated in successful intromission by a male. However, relatively few individuals were involved; these 10 successful pairings involved only 4 of the 10 males and 4 of the 23 females. Of the 23 females in the colony, 3 females each laid 1 clutch of eggs. Eight of 18 eggs from 2 of the clutches hatched at between 84 and 91 days. None of the three eggs in the third clutch hatched. All hatchlings appeared to be healthy.



Dissections of all eggs that did not hatch revealed that all such eggs were infertile. As judged by their appearance and by palpation, a number of additional females developed enlarged ovarian follicles, but for reasons unknown, these follicles were resorbed.

The mating and egg-laying of the BTS at NWRC is an important achievement as it marks only the second time in the United States this species has successfully been bred, and possibly only the fourth time worldwide. Moreover, the information gained from this work should provide greater success at inducing reproduction in captivity, enabling future laboratory testing of potential reproductive inhibitors.